A

TATA ENERGY RESEARCH INSTITUTE
BANGALORE CENTRE

AND

INDO-GERMAN INDUSTRIAL ENERGY EFFICIENCY PROJECT

EIGHTH PROGRAMME

ON

" PRACTICAL ENERGY AUDIT "

SEPTEMBER 26-28, 1996

EFFECTIVE ENERGY MANAGEMENT STRATEGY

TATA ENERGY RESEARCH INSTITUTE
BANGALORE

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1.0 INTRODUCTION

The manufacturing industry in India accounts for about half the total commercial energy used in the country. The high energy intensity of Indian Industry compared with advanced countries, the increasing problems of availability of energy and their ever escalating costs strongly point to the immediate need for effective control on the use of energy.

It is believed and often proved by actual studies, that a reduction in energy consumption by about 10-15 percent is a realisable goal in a large number of industries, by better and effective energy management at unit level. And these can generally be achieved with little or no additional investment. Much more is achievable with some investment.

Any saving than can be achieved in energy costs, directly add to the profit figures. While this is also true, in respect of other direct costs as well i.e., labour and material costs, it is much harder and more difficult to achieve reduction in their costs.

Another area by which profitability of an enterprise can be improved is by increasing production and market share; but these obviously require additional investments on expansion of manufacturing facilities and man-power, and involves added management and marketing effort: and a small portion of increased sales volume contributes to profits.

The real benefits than can be derived from improved energy usage is not fully appreciated. Various exhibits in Appendix-1 show analysis of the significance of energy costs in relation to manufacturing costs and profits in wide range of industries. The inference is obvious; any improvement in energy usage efficiency would have directly improved this profits dramatically.

It is seen that in most cases where energy costs form a significant share of manufacturing costs, a ten percent saving in energy costs could have improved their profit figures by 25-50 percent. The potential for improving profits through increased energy efficiency is truly enormous.

This is no less true in case of industries where the energy costs form a smaller percentage of total manufacturing costs. More often there is a mistaken notion that since the energy costs form a small proportion of manufacturing costs, nothing much is gained in allocating time and resource on controlling energy costs. Nothing can be farther from the reality as can be seen from the exhibits.

While the situation from industry to industry may vary, energy cost savings to the extent of 10-30 percent is very feasible atleast in those where serious study has not yet been attempted and about 5-12 percent even in well managed industries with good record of energy management.

One can visualise the improvement in profitability besides improvement in the competitiveness of Indian manufactured goods in world market, which reduction in energy costs could result in without any major investment.

2.0 PURPOSE OF ENERGY MANAGEMENT

The prime purpose of energy management concept is to provide the manufacturing plants with a measured analysis of their consumption and costs, and to provide the plants with the information leading to areas where energy saving opportunities may exist.

This will involve systematic study of energy usage pattern. This also involves, in-depth study and measurement of energy consumption related parameters and its analyses, and identifying viable opportunities for energy saving.

Energy management has to be at enterprise level, and this broadly comprise:

- Establishing a management structure for energy management.
- Initiating energy management process, with all its ramifications.
- Developing procedures to ensure that it becomes an on-going exercise, and energy monitoring becomes a permanent exercise.

Energy Management is not a one-shot affair but needs constant monitoring. An improvement once achieved need not remain permanent, and can easily return to pre-improvement state, if not regularly monitored.

3.0 POTENTIAL BENEFITS OF E.M.

It is common that many companies and plants have not given attention to identify even simple energy conservation measures with short payback periods, and many who have identified such opportunities fail to implement them. Many studies show that the main barriers to action on energy conservation are typically:

- lack of knowledge of what is technically possible
- inappropriate financial analysis methods
- management attitudes to energy efficiency

The greatest successes generally occur at companies where management supports an integrated energy management programme and is seen to support it.

The specific benefits achievable through energy management at plant level could include :

- lower production costs and higher profits - energy costs can often represent a significant proportion of overall manufacturing costs; energy cost savings are thus a direct contribution to company profits and can be significant for energy intensive industries;

- better competitive position - companies achieving savings in energy costs are in a position to cut product costs and thus improve their competitive position against others or in export markets;

- improved ability to withstand future energy cost increase or energy curtailments;

- improvements in productivity - energy management programmes can help identify productivity improvement and cost reduction opportunities that may relate to areas other than energy;

- environmental benefits - saving energy almost always leads to lower emissions from manufacturing plants (e.g. less smoke, less production of sulphur dioxide, lower NOX emissions).

Energy intensities - the amount of energy consumed per unit of output - vary widely depending on the product in question, the type of manufacturing process, the type of fuel, age of equipment, size of the plant and operating practices. However, savings for a plant which is starting an energy management programme are often 20 to 30 percent of present energy consumption, and even more in many cases. **ENERGY CONSERVATION MAKES VERY GOOD BUSINESS SENSE.**

4.0 BASIC PRINCIPLES OF E.M.

Energy management is a disciplined activity, organised for the more efficient use of energy without reducing production levels or lowering product quality, safety or environmental standards.

Energy conservation can be taken to be the reduction in the amount of energy consumed in manufacturing a given quantity of product or providing a particular service. Conservation does not mean reducing manufacturing output or doing without services previously enjoyed: it simply means utilising available energy resources more efficiently.

A broad understanding and appreciation of some general principles is important:

- The manner and extent of all energy use should be examined, including the appropriateness of the process/plant items used and the size of the plant item. This examination should, of course, be carried out to the level of detail justified by the cost of energy consumed in the corresponding stage of the process. Initially, most effort should be directed towards energy intensive processes.

- An essential element of energy conservation is the systematic measurement of plant energy and material flows. Consistent units and definitions should be used if measurements and comparisons with other processes are to be meaningful.

- In order to carry out accurate energy and material flow measurements, the use of properly calibrated and maintained instrumentation (either portable or permanently installed in the plant) is necessary.

Adequate instrumentation is required for both diagnostic "energy audits" and for the optimum control of energy use during normal plant operations.

- Process waste, such as the production of offgrade products, is wasteful of energy and other important elements of manufacturing cost. Reduction in waste is particularly important where the materials involved have high intrinsic energy contents. Metals, glass, paper, plastics and refractories are examples of high intrinsic energy materials.

- Much conservation work is concerned with trying to achieve the same process transformation with a lower input of energy, or attempting to increase the amount of work done by a given amount of energy input. Most process energy is lost ultimately to the outside environment in the form of heat. The maximum amount of useful work should be obtained at each stage of temperature or pressure reduction in the process. Sources of heat loss should be identified and the process examined to see if the heat loss can either be prevented or recovered for a lower grade process use.

- Each individual energy conservation saving should be analysed to ensure that it does not cause process changes which result in an increase in the overall amount of energy used or detrimental effects on the product or production rate.

- Some energy conservation improvements require investment in new equipment. Investment in such equipment is likely to be inhibited if there is not an appropriate economic framework and guidelines for the evaluation of energy conservation projects.

Much energy conservation can be achieved by the cumulative effect of many small efficiency improvements. Although it is sometimes possible to identify one or two major improvement areas, many individually small items may be the optimum approach.

Energy management requires a logical and comprehensive management approach. Experience shows energy savings become significant, long lasting and progressively improve, when they are achieved as a part of overall plant energy management programme. A systematic and structural approach is essential to realise the full potential savings. Improvement once achieved need not be permanent and can easily return to pre-improvement state if not regularly monitored.

Energy management is a continuing management process. It not only involves energy audits to identify energy saving opportunities in the plant, but also includes evolving management strategies for sustained implementation and achieving progressively improved results.

5.0 SCOPE OF ENERGY AUDITS

a. House keeping/Preliminary Audits

These cover - good house-keeping, i.e., maintenance, standard do's & dont's, consumption monitoring, training operatives, publicity & education, routine checks for leakages, improving work practices etc., requiring no or very small investment. These result in a large number of small improvements, but the cumulative effect could be quite significant. This is best done with in-house effort. A saving of 2-10 percent is normally achievable for this exercise.

b. Comprehensive Energy Audits

These would be generally instrumented studies, based on multi-dimensional measurements & analysis of various parameters. These may include working out Energy - material balance; experimentation/ trials; modifications; minor replacements; retrofitting etc. - from which significant energy savings are possible in a short period.

There are no standard check - lists or readymade solutions, but each situation has to be studied individually and solutions evolved.

Normally the implementation of solutions require some investment. The test for viability of a recommendation is the 'pay-back' period of investment.

This audit could yield savings between 5-15 percent energy savings.

C. Technology Audit

These involve replacement of whole equipment 7 process, energy efficient technology transfer and such as those which require large investment and those which can be done at the planning stage of the project.

6.0 MANAGEMENT PROCESS

A. Environment

Basically, Management is the effective utilisation of human and material resources to achieve stated objectives.

Effective energy management within an industrial enterprise requires:

- Commitment of all, and particularly the active commitment of top management to authorise the necessary resources.

- Communications across all levels in the company, from the highest management levels to the operating personnel and shift workers.

- A structure within the company which results in properly identified responsibilities and lines of authority.

- Involvement of personnel at all levels in the setting of energy efficiency improvement goals, and in the improvement of operating standards and performance generally.

- Focal point for all energy related matters, and involvement of decision makers of the company.

- Expertise in all technical & economic matters relating to energy use.

The continuing commitment, concern and interest of top management in energy management are essential pre-requisites for a successful programme.

B. Role of Top Management

The most essential requirement for a successful energy management programme is the commitment and dedication of top management. They must be totally convinced of the need, necessity, and benefits of energy management. They must be willing to provide the resources, both personnel and capital. They must visibly demonstrate and communicate their commitment to the employees of the enterprise.

They must demonstrate their commitment and involvement in every manner possible and at every available opportuntiy. Top Management must originate the programme, generate momentum and then maintain momentum. Adequate personnel and financial resources must be provided and responsibilities delegated to implement activities and projects to achieve the predetermined energy conservation goals. Progress should be monitored and goals reviewed and revised as necessary.

C. Structure

Once a corporate decision has been made to start an energy management programme, a special management structure within the company's organisational framework needs to be created in view of the special role of energy as a common input across different divisions, departments and sections.

The energy management structure will depend on the size of the enterprise, its functional organisation, and its manufacturing activities. In large enterprises having several plants, an Energy Manager reporting to the plant manager and to the corporate energy manager would be responsible for the energy management programme in each plant.

Responsibilities at divisional levels would rest with energy management coordinators in each division. At the departmental level, the most effective practice has been to make a supervisor responsible for the energy management programme. The structure in medium size companies could be similar to that for a single plant in large companies. In small companies, it may not be necessary to have an energy manager at all. This role could be assigned to any of the managers responsible for engineering, maintenance or production, or to a senior staff member.

D. Energy Committee

A useful practice is for the energy managers and coordinators to be assisted by committees consisting of representatives of various functional areas such as engineering, maintenance, utilities, production, etc. These committees would assist in the developing programmes and formulating plans, serve as a channel for communication back to personnel in their functional area, and also serve as a forum for review and generation of ideas.

While considerable management effort is expended in monitoring raw material consumption or production output, very little or no real attention is generally paid to monitoring energy consumption. It is generally ignored in the present status belief that the energy use cannot be controlled. A focal point in the form of Energy Manager would very essential, particularly in large organisation.

The precise duties of an Energy Manager will depend on the size and type of organisation, but they will include some or all of the following:

- To generate interest in energy conservation and sustain the interest with new ideas and activities.

- To maintain summaries of energy purchases, stocks and consumption, and to review and report on energy utilisation regularly.

- To be the focal point for departmental records of energy use, and to ensure that the records and accounting systems are uniform and in consistent units.

- To co-ordinate the efforts of all energy users and to set challenging but realistic targets for improvement.

- To give technical advice on energy-saving equipment and techniques, or to identify suitable sources of sound technical guidance on specialised subjects.

- To identify areas of plant activity which require detailed study and to give priority to such activities.

- To maintain records of all in-depth studies and to review progress.

- To provide a basic handbook of good energy practice for the plant operating department.

- To give specialist advice to purchasing, planning, production and the other functions of all aspects of energy conservation, especially on the long-term implications.

- To ensure that, in making improvement in energy efficiency, health and safety are not adversely affected.

- To liaise with committees and working groups within his own industry and, provided no confidential data are involved, to exchange ideas on cost cutting techniques and performance figures for similar processes.

- To maintain contacts with research organisations, equipment manufacturers and professional bodies to ensure that he is up-do-date on significant developments in the field of energy conservation.

- To remain up-to-date on national energy matters and to advise senior company management on such topics, as well as cooperating with government departments in energy-related matters.

Energy Managers need to display a high level of resourcefulness and adaptability in addition to their sound technical grounding. This is a job of investigation, analysis, recommendation and persuasion. They need to pull together many disciplines - technical/production, personnel and financial - to achieve the twin objectives of reducing energy costs and improving energy efficiency.

7.0 TYPICAL PROGRAMME FOR E.M.

- Audits of energy consuming activities, to document clearly all facets of energy use and to identify conservation opportunities.

- Target/goals for energy efficiency improvements, which will be based on the initial plant audits, and which will include careful consideration of implementation schedules.

- Monitoring of energy consumptions and related production activities, on a regular basis, in order to check on progress towards targets, to identify problem areas at an early stage, and to provide data with which to develop standards for energy consumption and to develop modified targets from year to year, as appropriate.

- Training programmes and the availability of technical and engineering information to encourage energy efficiency, and to provide employees with the needed skills to achieve improve performance.

- Development of capital investment programmes oriented to improved energy efficiency, including better control systems for operating plants.

- Comprehensive and clear reporting systems, including financial controls and accountability for energy efficiency performance within appropriate departments or subdivisions of the plant, including the analysis of variations in the actual and expected performances.

8.0 STEPS & STRATEGY FOR E.M.

A. Responsibility for energy use

The responsibility for controlling energy use should be firmly tied to - (a) responsibility for the control of related resources and (b) accountability for achieving objectives. Thus the areas for the managerial control of energy will generally correspond with those for the use of other resources. For example: in manufacturing industry, the responsibility for the control of energy costs will rest with line managers along with that for labour, materials and other costs.

B. Energy Accountable Centers (EAC)

An energy accountable centre (EAC) will usually correspond with an existing cost control or profit centre and may, for example, be based on a single building, the whole of a small manufacturing site, a production line, a central boiler house, or some other specific part of a manufacturing process. Information on the results achieved by each centre can then be correlated with energy consumption.

The amount of energy used by an EAC is a given period is calculated from the measured quantities of fuel and electricity, and expressed in standard units. An appropriate index is chosen as a measure of energy used in relation to the results achieved. It is often energy used per tonne of product, or some other measure of production output. The amount of energy expended in achieving a result corresponding to the selected unit is the specific energy requirement.

For each EAC, agreed standards of performance for energy use are setup. When energy is used mainly for heating or cooling buildings, the standards usually take account of seasonal variations in the weather. Similarly, in manufacturing industry, allowances are made for variations in the level of production, changes in the product mix, or other factors which directly affect performance.

The standards serve a yard-sticks for controlling energy use and assessing performance. They can also be used for comparing the performance of one EAC with another. It is important to consider the rate of production compared with the plant capacity, as the specific energy ratio increases with reduced production rates. The relationship between the two-production level and specific energy consumption needs to be established.

Regular comparisons of the actual performance of an EAC against the agreed standards are made, at intervals and at management levels appropriate to the costs involved. The reason for any significant deviation, or variance of energy use from the standard is sought and if deviation unfavourable, corrective action is taken.

C. Energy efficiency improvement targets

When standards for current performance have been defined and accepted in practice, targets are set for improvements in the efficiency of energy use.

These may be set arbitrarily, e.g. a 5% improvement in energy efficiency in 6 months, or they may be set statistically e.g. by using the performance indices for those periods when the corrected performance has bettered the mean performance.

The improvements in energy efficiency may involve change in operating practices, modifications to existing plant or buildings, or investment in systems which are more energy efficient. Cost-effective measures are implemented when financial and other constraints permit. Progress towards the target is monitored and when it has been reached and performance has been sustained at the new level, the target can become the new standard and a new target is set. The cost savings achieved and the return on investment can then be calculated from the improvement in the efficiency of energy use.

9.0 IMPLEMENTATION

With the appointment of a corporate energy manager and the establishment of an appropriate energy management structure, the process of planning and initiating energy management activities can be undertaken.

Broadly, the components of the process are :

A. Energy Audit

For the purposes of implementing a monitoring and target setting scheme a energy audit need be performed. The aims are:

i. to identify the main energy users and quantify their annual energy consumptions.

ii. to ascertain the optimised energy data.

iii. to determine the availability of energy/production data.

iv. to investigate the distribution systems for the site services and note any existing metering.

v. to prepare energy and process flow diagrams for the site.

B. Energy Accountable Centres

Each energy accountable centre (EAC) requires a meter to measure the energy consumed over a period and a means of measuring/assessing the production (or other specific variable) over the same period.

As far as possible the EAC's identified should correspond with existing . cost control centres on the site.

The decision on the EAC's to be included in the monitoring scheme should be made in the following basis:-

i. The annual energy cost of each "EAC"
ii. The expected bi-annual savings in each "EAC" (can be 5% for the majority of cases).
iii. The existing departmental managers areas of responsibility

It is not necessary to cover the whole of a sites' energy consumption, but just the main areas of use.

C. Monitoring period

Once the EAC's have been decided and any extra meters required have been installed, the monitoring period can commence, Data on energy consumptions, production throughput, days etc are collected over a period of 10 weeks or more.

These data will form the basis for setting the standards and targets.

Meter readings and data gathering should be done every week except for a very large EAC's where readings would be justified on a daily basis.

D. Setting of standards and targets

The first step is to determine the specific variables that affect the energy consumption in each EAC. Regression analyses of the data will show whether a reasonable correlation exits between energy consumption and the specific variable being considered. Once the most suitable variable has been decided then the equations of the standard line is that obtained by regression analysis of the data from the monitoring period.

The use of a computer for monitoring schemes is desirable, although the data analyses and weekly report sheets can be produced by hand if manpower permits.

E. Full implementation of monitoring scheme

When standards and targets have been set for each EAC then the full monitoring scheme can commence. Meter readings and production data etc., should be collected at the same time each week and a weekly report sheet produced for distribution to personnel around the site. The performance of the EAC's can also be portrayed graphically.

The results of the monitoring scheme should be reviewed every month by the Energy Committee and any appropriate actions initiated.

Resetting of standards and targets should be carried out as necessary.

10.0 OVERCOMING BARRIERS

Energy Managers and others with responsibility for maintaining and improving energy efficiency face many difficulties. One particular problem is obtaining finance for energy efficiency improvement projects. A common complain is that money is simply not available for this type of investment.

Part of the reason lies in the weakness of the cases that are presented to the financial decision makers. Energy managers normally have limited spending authority; their job is to make technical judgements and to advise more senior managers on how to spend money in their specialised area. The senior manager's job is to take the broader view and to consider the organisation's overall interests. In doing this, he will receive advice form middle managers in other specialised areas such as production, research and marketing.

unfortunately for the energy manager, his case often fails to be sufficiently convincing to compete successfully with the many other claims on scarce capital resources. He will find himself at a particular disadvantage if he fails to communicate well with the finance executive, who may have little technical understanding.

A. Preparing the ground

High energy efficiency, or any other sort of efficiency for that matter, will be difficult to achieve unless an important set of organisational and managerial circumstances prevails it is will not be in the power of the energy manager to bring about all of these, but he should wield some influence in certain areas, if his selection has been proper.

B. Involving the decision-makers

The first requirement is that the financial decision-makers are fully alerted of the real benefits of energy efficiency improvement. Energy costs may be only a small proportion of an organisation's annual turnover but probably represent a significant proportion of total profits.

Senior managers need to realise that reductions in operating costs - such as for energy - can add directly to profitability. If individual investments in energy efficiency improvements offer acceptable rates of return and are within the company's ability to undertake and operate, then it is difficult to argue against their implementation. Unfortunately, not all senior managers appreciate this point, in many cases concentration is understandably focused on the major issues facing the organisation's development. Unless they are receptive to the energy conservation objectives, it is unlikely results can be achieved.

C. Competing with other demands for funds

Most organisations have a far more permissive attitude about investment in their mainstream activities, than they have about energy efficiency investment. A payback of up to ten years will be accepted for investment in production, whereas returns of capital within one to two years are often demanded for energy efficiency improvement.

To some extent this is understandable. A business is not run on energy saving an organisation must keep ahead of the competition in design, performance and price or go out of business. On the other hand, energy cost reduction can provide a valuable contribution, for which carefully selected, assessed and well-argued proposals importance of having an effective Energy Manager, a receptive senior management and both being able to communicate well with financial managers.

D. Lack of information about new technology

Even when an organisation is aware of a range of appropriate energy efficiency improvement measures, it may still desist from investing because of insufficient information about the techniques involved. This may be especially true when new technology is involved. Valuable information can be obtained from existing users if they are co-operative. The skill, disciplinary of the Energy Manager plays a large part.

E. Perceived risk of failure

Many organisations hold back from embarking on energy saving projects, because they fear that things may go wrong and more money may be wasted than saved. This is especially true with techniques outside their areas of expertise or experience. Such fears are very understandable but often exaggerated. Much can be done to allay their focus making full use of available information and existing user's experiences.

F. Lack of required expertise

Projects may not go ahead because there are no suitably qualified and able staff to implement and run them. Consultants can play a valuable role in the initial stages of selecting and assessing opportunities, specifying equipment, assessing tenders, installation and commissioning, acceptance testing and utilisation.

However, more users will eventually wan to take over direct responsibility for their projects. Specialist technical training is obviously very important here.

11.0 INVESTMENT APPRAISAL

Most energy efficiency investment appraisal extends no further than calculating the expected payback time, i,.e., capital costs divided by the expected annual cost savings. This is a good measure of the likely acceptability of a project; no amount of more sophisticated analysis will turn an anticipated 30 year payback time into a golden investment opportunity.

Simple payback analysis is useful to eliminate the no-hopers, but will not show which project represents the best opportunity out of a number of options. It cannot do this because it fails to take into account:

- the timing of costs and benefits
- the likely residual value of assets at the end of the project life (they could be sold)
- savings accruing after the payback term (these may increase with time)

For example, simple payback cannot tell which of two opportunities, both with the same payback period, represents the better investment. Nor can it confirm that a prospective none-year payback is as good an opportunity as it may seem. Such a rapid return is often quoted for difficult and demanding measures such as electronic energy management systems. In fact, these can take the much as a year to install and commission and a further two years for the purchaser to learn how to use them properly. Under these circumstances, simple payback periods are relatively meaningless.

To establish the actual rate of return from an investment and to select the best opportunity, a more applied approach may need to be taken.

12.0 EDUCATION, TRAINING AND MOTIVATION

A. Public Relations

A well thought out public relations should convince all staff of the need for good standards of housekeeping and energy awareness. They should appreciate that it is in their best interests that all unnecessary and excessive use of energy be eliminated.

Energy cost savings add directly to profit. They will help safeguard employees' future by improving the firms's economic well-being and competitiveness. Moreover, each rupee saved is equivalent to many rupees' worth of extra production. Energy efficiency is actually an easy way to increase the earnings of the firm. It is important to emphasise that sacrifices are not being sought, nor are the staff being expected to work in less than satisfactory conditions.

Early encouraging results are unlikely to be sustained indefinitely. People to tend to drift back into their former habits, but the right climate of opinion will be established for introducing more sophisticated, expensive and lasting measures at a later date.

B. Awareness and Information

In most plants, employees have little or no idea of the amounts of energy being consumed within their plant, their section and even the equipment being operated by them. In such a situation, energy conservation obviously carries no meaning. Employees can be stimulated to support energy management by making them aware of the amounts of energy they are using, the associated costs, the many ways to save energy, and the importance of energy conservation for the company's profitability and the nation's growth.

The information can be provided in the form of comparisons of historical trends, current values and goals for overall energy use, energy intensity, etc. in both physical and monetary terms; energy conservation checklists for each manufacturing operation outlining simple and routing housekeeping measures to save energy, audio-visual presentations, and other general literature.

Information must be presented in a manner which facilities comprehension. If the information is too technical, too much, too sketchy, or too dull, it is likely to be ignored or not understood.

Terms that employees can relate to in everyday life should be used. For example, a sign saying "stop steam leaks" will not be as effective as a sign saying "A" quarter inch diameter steam leak costs Rs.30,000 per month.

Commitment to reducing energy costs and thereby improving energy efficiency, must come from the top. Of equal importance is the need for energy cost savings to be acknowledged throughout the organisation as a direct contribution to profitability. Success in this field can be measured "on the bottom line" and the wider these results are circulated, the more enthusiastic, becomes the commitment from both management and workforce.

C. Training

Training is also an important means of both information and involving people at all levels in an energy management programme. For operating personnel, training is required in energy efficient operation of equipment and the practicalities of energy saving. This could be integrated into the orgainsation's other training programmes.

Upper level management also need to be informed of the overall energy situation, energy costs in relation to other costs, the energy management programme - its goal, achievements, technical, economic and behaviourial aspects etc.

D. Involvement

Motivation is based on involvement. Commitment and sense of personal accountability can be generated only through total involvement of plant personnel at all stages from initiation to implementation of the energy management programme.

Operators and maintenance staff should be involved actively as they are ultimately responsible for execution of activities in the programme. Also, they are often in a better position to recommend areas for savings or improvements. The most effective way of involving them is by simply going out and talking to them regarding goals, achievements, problems, and progress or lack of progress. This demonstrates to them that the energy conservation programme is real and also that their role is important in success or failure of the programme. Another means of involvement is through training.

Supervisors and middle level management should be involved by assigning them responsibilities for implementing and monitoring activities and submitting performance reports to top management, and by getting them to interact and communicate with operations and maintenance staff on progress and problems. If possible, energy management activities should be made a part of each supervisor's performance or job standard.

D. Incentives and Rewards

Another method motivating people is through incentives and rewards. Monetary rewards could be given to employees for suggestions leading to substantial energy savings, for innovative ideas or solutions, and for outstanding efforts in implementation of energy conservation activities. Wide publicity of effective idea provides an added incentive in the form of public recognition. Other incentives could be designed to meet the needs and attitudes of plant personnel.

One possible danger with monetary rewards is that it makes people accustomed to receiving extra compensation for an effort that really is part of their job. If rewards are stopped later, there could be a reduction in ideas that could affect original gains.

13.0 PUBLICITY AND PROMOTION

Publicity and promotion are essential to create a climate for the energy management programme successful. Some commonly used means for publicising and promoting an energy conservation programme are:-

- One article per month written in the company or plant paper. Include a personal profile on people performing energy management activities and atleast one good energy conservation idea that was implemented.

- Articles from the company or plant paper used to obtain local newspaper interest and coverage.

- Posters and pamphlets on energy conservation.

- Operating department note paper with different energy conservation opportunities and ideas printed on the paper.

- Plant-wide high-visibility vehicles or equipment are used to carry signs publicising energy conservation.

- Energy conservation performance results for plant and department posted monthly by the plant energy manager and the unit representative.

- Plant energy manager and unit representatives face-to-face energy conservation discussions with plant personnel. The opportunity checklist can be used for discussion topics.

- Unit representative and several unit personnel conduct quarterly on-site reviews, a walkthrough of the unit looking for energy saving opportunities.

- An agenda item in energy conservation included at staff meetings.

- Energy conservation material provided to first-line supervisors for hourly employee discussion periods atleast quarterly.

- Quarterly meetings held in the plant for all unit representatives.

- Annual meetings held for plant energy managers.

- An energy awareness Day is set aside in the plant twice a year.

- A company energy logo developed and adopted.

14.0 SUMMARY

A detailed step by step approach for installing a E.M. is given in Appendix-2.

Setting up the E.M. system involves twelve steps,as given below:

a. Collection of Data

Most production units report on a weekly basis for management information and accounts. Energy consumption is usually taken as global figures - e.g. total electricity and total services (oxygen, water, fuel oil, etc.,). This information can be roughly analysed into specific energy consumption related to production output.

b. Identification of meters

All meters should be identified with details of areas they cover. Any major user areas which are not specifically covered by individual meters should be detected.

c. Energy usage of designated areas

Using the existing meters, measurements should be taken over a period of two weeks. The detailed information should then be tabulated to indicated major energy users.

d. Selection of High Priority Areas

Using the information obtained above, priority areas need to be selected for full targeting and monitoring.

Meters should be installed where necessary, in all defined high usage areas to enable detailed readings to be taken. It is not necessary to measure each individual item of plant.

e. Detailed Monitoring of Selected Areas

After the designated meters have been installed it is necessary to decide on a frequency for meter reading - eg. daily, weekly. Monitoring sheets are prepared for collection of the information by the responsible plant personnel. The information is then transferred to a weekly report which is forwarded to the designated Energy Manager. This monitoring procedure is carried out over a period of four to six weeks.

f. Analysis of Monitored Information

The analysis of the information thus obtained will determine which areas require a detailed breakdown of plant operation. The Energy Manager will carry out this work in conjunction with the respective Plant Managers.

g. Breakdown of Priority Areas

Most of the plant can be broken down into specific operating practices which have a direct bearing on energy consumption. This stage requires the input from all personnel involved with the plant operation.

h. Standard Operating Procedures

After the standard operating procedures have been finalised it is necessary to carry out a training programme to ensure that plant personnel are fully conversant with the reasons for change.

i. Setting of Agreed targets

Using historical data, when available, in conjunction with the information obtained during the initial four to six week monitoring period, targets are set for each segment of the plant operation. It is important that the targets are agreed with the responsible plant Manager and are realistic.

j. Monitoring system

The monitoring system must be robust to ensure consistency. The information gathered is discussed by each Plant Manager during the morning production meeting, with action points referred to each Section Manager. After the initial trial period it will become obvious to each Plant Manager that the monitoring periods should be reduced to individual shifts.

k. The report structure

It is vital that the project has correct level of management involvement. This ensures that priorities are correctly identified and progress is maintained.

l. Project Group Meetings

After a period of assessment including the readjustment of targets coordinating meetings should be held at three monthly intervals to analyse targets ad monitoring procedures.

15.0 CONCLUSION

Energy Management is not a one shot affair. Rather, it should be a continuing programme whose focus and strategies may change over time. The overall objectives, however, are invariant.

Results of the energy management programme should be reviewed annually to determine whether the objectives and expected savings have been achieved. Based on the review, policies should be reassessed and the plan of action revised. The energy reporting system should become an integral part of existing management information systems. Employee motivation should be sustained. Technological developments should be continuously monitored and evaluated. Only by sustaining the momentum and the efforts will energy savings continue to accrue.

REFERENCES

- *Varous NIFES, Training Manuals*
- *Energy Managers Workbook*
- *The Role of Energy Managers - Energy Efficiency Office - U.K.*
- *Energy Audits - Energy Efficiency Office - U.K.*
- *Industrial Energy Conservation - D.A. Reay*

CONTRIBUTION OF ENERGY COST & INFLUENCE ON PROFITS

CEMENT INDUSTRY

'Rs. in Crores'

Year	1991-92	1992-93	1993-94
No. of Units	15	15	14
Direct Costs			
Raw materials	538	760	932
POWER & FUEL	**853**	**985**	**841**
Salaries & Wages	222	270	267
Consumable Stores	335	245	311
Repairs & Maintt.	116	131	126
Total Direct Prodn. Costs	2064	2391	2477
(Energy Cost %)	(41)	(41)	(34)
A. Gross Profit	619	423	426
Increase if energy cost were to be less by 10%	14	23	20
B. Gross Profit less interest	398	144	138
Increase if energy cost were to be less by 10%			
i. Percentage	21	68	61
ii. Rs. in Crores	85.30	98.50	84.10

CONTRIBUTION OF ENERGY COST & INFLUENCE ON PROFITS

TEXTILE INDUSTRY (COMPOSITE MILLS)

'Rs. in Crores'

Year	1991-92	1992-93	1993-94
No. of Units	34	34	26
Direct Costs			
Raw materials	1585	1881	1475
POWER & FUEL	**343**	**425**	**357**
Salaries & wages	437	482	366
Consumable stores	310	338	248
Repairs & Maintt.	59	61	54
Total Direct Prodn. Costs (Energy cost %)	2734 (13)	3187 (13)	2500 (14)
A. Gross Profit	423	448	457
Increase, if energy cost were to be less by 10%	8	10	8
B. Gross Profit less interest	236	179	263
Increase, if energy cost were to be less by 10%			
i. Percentage	14	24	14
ii. Rs. in Crores	34.30	42.50	35.70

CONTRIBUTION OF ENERGY COST & INFLUENCE ON PROFITS

PAPER INDUSTRY

'Rs. in Crores'

Year	1991-92	1992-93	1993-94
No. of Units	21	21	20
Direct Costs			
Raw materials	790	950	1041
POWER & FUEL	**442**	**512**	**536**
Salaries & Wages	189	208	209
Consumable Stores	303	342	259
Repairs & Maintt.	71	83	85
Total Direct Prodn. Costs (Energy cost %)	1795 (25)	2095 (24)	2130 (25)
A. Gross Profit	317	300	338
Increase, if energy cost were to be less by 10%	14	17	16
B. Gross Profit less interest	142	109	155
Increase, if energy cost were to be less by 10%			
i. Percentage	31	47	35
ii. Rs. in Crores	44.20	51.20	53.60

Source : *Company annual Reports Summary - Financial Performance of Companies - ICICI Portfolio*

CONTRIBUTION OF ENERGY COST & INFLUENCE ON PROFITS

ALLOY STEEL

'Rs. in Crores'

Year	1991-92	1992-93	1993-94
No. of companies	5	5	5
Direct Expenses			
Raw material	343	405	388
POWER & FUEL	**117**	**161**	**170**
Salaries & wages	56	64	67
Consumable stores	57	72	76
Repairs & maintt.	23	26	23
Total direct cost of prodn.	596	728	724
(Energy cost %)	(20)	(22)	(23)
A. Gross profit	48	43	72
Increase, if energy cost were to be less by 10%	24	37	24
B. Gross Profit less interest	-7	-24	0
Increase, if energy cost were to be less by 10%			
i. Percentage	(+4)	-	(+17)
ii. Rs. in Crores	11.70	16.10	17.00

CONTRIBUTION OF ENERGY COST & INFLUENCE ON PROFITS

PETRO-CHEMICALS

'Rs. in Crores'

Year	1990-91	1992-93	1993-94
No. of companies	10	10	10
Direct Expenses			
Raw material	932	542	578
POWER & FUEL	**227**	**134**	**131**
Salaries & wages	120	78	88
Consumable stores	100	40	34
Repairs & maintt.	87	25	27
Total direct cost of prodn. (Energy cost %)	1466 (15)	819 (16)	858 (15)
A. Gross profit	406	111	151
Increase, if energy cost were to be less by 10%	1	12	1
B. Gross Profit less interest	197	23	56
Increase, if energy cost were to be less by 10%			
i. Percentage	11	58	23
ii. Rs. in Crores	22.70	13.40	13.10

CONTRIBUTION OF ENERGY COST & INFLUENCE ON PROFITS

NITROGENEOUS FERTILIZERS

'Rs. in Crores'

Year	1991-92	1992-93	1993-94
No. of Units	5	4	4
Direct Expenses			
Raw material	1734	1723	1541
POWER & FUEL	**320**	**367**	**451**
Salaries & wages	114	132	153
Consumable stores	64	225	242
Repairs & maintt.	76	98	98
Total direct cost of prodn.	2308	2545	2485
(Energy cost %)	(14)	(14)	(18)
A. Gross profit	368	423	483
Increase, if energy cost were to be less by 10%	9	9	9
B. Gross Profit less interest	152	136	193
Increase, if energy cost were to be less by 10%			
i. Percentage	21	27	23
ii. Rs. in Crores	32.00	36.70	45.10

CONTRIBUTION OF ENERGY COST & INFLUENCE ON PROFITS

GLASS & GLASS PRODUCTS

'Rs. in Crores'

Year	1991-92	1992-93	1993-94
No. of Units	2	2	2
Direct Expenses			
Raw material	12	12	11
POWER & FUEL	**8**	**8**	**11**
Salaries & wages	9	9	10
Consumable stores	1	1	2
Repairs & maintt.	1	1	2
Total direct cost of prodn. (Energy cost %)	31 (26)	31 (26)	36 (31)
A. Gross profit	5	(-1)	9
Increase, if energy cost were to be less by 10%	16		12
B. Gross Profit less interest	2	(-6)	6
Increase, if energy cost were to be less by 10%			
i. Percentage	40		18
ii. Rs. in Crores	0.80	0.80	1.10

CONTRIBUTION OF ENERGY COST & INFLUENCE ON PROFITS

CERAMICS & GLASS

'Rs. in Crores'

Year	1991-92	1992-93	1993-94
No. of Units	7	7	7
Direct Expenses			
Raw material	128	124	110
POWER & FUEL	**36**	**36**	**42**
Salaries & wages	36	36	43
Consumable stores	24	25	27
Repairs & maintt.	14	15	11
Total direct cost of prodn.	238	236	233
(Energy cost %)	(15)	(15)	(18)
A. Gross profit	34	44	58
Increase, if energy cost were to be less by 10%	11	9	7
B. Gross Profit less interest	9	21	35
Increase, if energy cost were to be less by 10%			
i. Percentage	40	17	12
ii. Rs. in Crores	3.60	3.60	4.20

CONTRIBUTION OF ENERGY COST & INFLUENCE ON PROFITS

CASTINGS & FORGINGS

'Rs. in Crores'

Year	1991-92	1992-93	1993-94
No. of Units	14	13	13
Direct Expenses			
Raw material	605	574	511
POWER & FUEL	**105**	**131**	**138**
Salaries & wages	101	100	111
Consumable stores	175	186	176
Repairs & maintt.	15	16	17
Total direct cost of prodn.	1001	1007	953
(Energy cost %)	(10)	(13)	(14)
A. **Gross profit**	155	138	158
Increase, if energy cost were to be less by 10%	7	9	9
B. **Gross Profit less interest**	56	22	39
Increase, if energy cost were to be less by 10%			
i. Percentage	19	59	35
ii. Rs. in Crores	10.50	13.10	13.80

CONTRIBUTION OF ENERGY COST & INFLUENCE ON PROFITS

VEGETABLE OIL AND VANASPATHI

'Rs. in Crores'

Year	1991-92	1992-93	1993-94
No. of Units	8	7	7
Direct Expehses			
Raw material	610	688	647
POWER & FUEL	**36**	**45**	**44**
Salaries & wages	23	27	30
Consumable stores	68	65	75
Repairs & maintt.	4	5	5
Total direct cost of prodn. (Energy cost %)	741 (5)	830 (5)	801 (5)
A. Gross profit	40	37	45
Increase, if energy cost were to be less by 10%	10	12	10
B. Gross Profit less interest	18	10	14
Increase, if energy cost were to be less by 10%			
i. Percentage	20	45	31
ii. Rs. in Crores	3.60	4.50	4.40

CONTRIBUTION OF ENERGY COST & INFLUENCE ON PROFITS

TUBES & PIPES INDUSTRY

'Rs. in Crores'

Year	1991-92	1992-93	1993-94
No. of Units	8	7	7
Direct Expenses			
Raw material	462	582	560
POWER & FUEL	**39**	**52**	**60**
Salaries & wages	39	46	53
Consumable stores	30	35	32
Repairs & maintt.	4	5	5
Total direct cost of prodn.	574	720	710
(Energy cost %)	(7)	(7)	(8)
A. Gross profit	67	72	77
Increase, if energy cost were to be less by 10%	58	72	78
B. Gross Profit less interest	5	8	14
Increase, if energy cost were to be less by 10%			
i. Percentage	78	65	43
ii. Rs. in Crores	3.90	5.20	6.00

BREAK-UP OF COSTS FOR THE YEAR 1993-94

Rs. in Crores

Category	Raw material	Salaries & wages	Power-Fuel
Hotels (5)	55	56	38
Man-made fibres (18)	3503	467	797
Composite mills (26)	1475	336	357
Paper (22)	1041	468	536
Castings & Forgings (13)	511	111	138
Alloy steel (5)	388	67	171
Aluminium (2)	515	121	308
Glass & Glass Product (2)	11	10	11
Ceramics & Glass ((7)	110	43	42
Petro-chemicals (10)	578	88	131
Nitrogenous fert. (4)	1541	152	415
Organic chemicals (7)	167	23	44
Cement (14)	932	266	841
Veg.oil & Vanaspathi (7)	647	30	44

DETAILED STEPS INVOLVED IN INTRODUCING ENERGY MANAGEMENT

A. Key Tasks of EM

i. *Energy Data Collection and Analysis*

☞ maintain records of all energy consumption in the plant.

☞ check the reading of all meters and submeters on a regular basis.

☞ specify additional meters required to provide additional monitoring capability.

☞ develop indices for specific energy consumption relative to production and maintain these indices on a monthly basis for all major production areas.

☞ set performance standards for efficient operation of machinery and facilities.

ii. *Energy Purchasing Supervision*

☞ review all monthly utility and fuel bills ; ensure billing is proper and that the optimum tariff is applied in each base.

☞ investigate and recommend fuel switching opportunities where a cost advantage to the company is possible.

☞ develop contingency plans to implement in the event of supply interruptions or shortages.

☞ work with individual departments to prepare annual energy cost budgets.

iii. Energy Conservation Project Evaluation

- develop energy conservation ideals and projects, working with in-house staff, equipment vendors and outside consultants.
- summarise and evaluate possible energy saving projects according to the company financial planning requirements ; perform the necessary economic analyses to permit management evaluation of the projects.
- obtain management commitment of funds to implement conservation projects.
- re-evaluate possible projects as the company operations change or grow ; evaluate energy efficiency of new construction, building expansion or new equipment purchases.

iv. Energy Project Implementation

- initiate equipment maintenance programmes for energy saving
- supervise the implementation of conservation projects, including specification of equipment, requests for quotation, evaluation of offers, ordering of materials, construction/installation, operator training, start-up and final acceptance.

v. Communications and Public Relations

- prepare monthly reports to management, summarizing monthly energy costs and consumptions as well as specific energy consumptions.
- communicate with all production and support departments, so that all participate in the energy management programme.
- develop an awareness programme within the company to encourage active participation by all employees in energy saving activities.

- ☞ develop training programmes to upgrade knowledge and skills of all levels of employees in energy related matters.

- ☞ publicist the company commitment to energy conservation where appropriate, providing information for press releases and internal notices, presenting papers in professional conferences, and entering the company in energy award programmes.

B. Checklist for Top Management

i. Inform line supervisors of :

- ☞ The economic reasons for the need to conserve energy.

- ☞ Their responsibility for implementing energy saving actions in the areas of their accountability.

ii. Establish a committee having the responsibility for formulating and conducting an energy conservation programme and consisting of :

- ☞ Representatives from each department in the plant

- ☞ A co-ordinator appointed by and reporting to management.

iii. Provide the committee with guidelines as to what is expected of them :

- ☞ Plan and participate in energy saving surveys.

- ☞ Develop uniform record keeping, reporting and energy accounting.

- ☞ Research and develop ideas on ways to save energy.

- ☞ Communicate these ideas and suggestions.
- ☞ Suggest tough, but achievable, goals for energy saving.
- ☞ Develop ideas and plans for enlisting employee support and participation.
- ☞ Plan and conduct a continuing program of activities to stimulate interest in energy conservation efforts.

iv. *Set goals in energy saving :*

- ☞ A preliminary goal at the start of the programme.
- ☞ Later, a revised goal based on savings potential estimated from results of surveys.

v. *Employ external assistance in surveying the plant and making recommendations, if necessary.*

vi. *Communicate periodically to employees regarding management's emphasis on energy conservation action and report on progress.*